

Exports, foreign direct investment, and the costs of corporate taxation

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Abstract This paper develops a model of a monopolistically competitive industry with extensive and intensive investment and shows how these margins respond to changes in average and marginal corporate tax rates. Intensive investment refers to the size of a firm's capital stock. Extensive investment refers to the firm's production location and reflects the trade-off between exports and foreign direct investment as alternative modes of foreign market access. The paper derives comparative static effects of the corporate tax and shows how the cost of public funds depends on the measures of effective marginal and average tax rates and on the elasticities of extensive and intensive investment.

Keywords Exports · Foreign direct investment · Corporate taxation · Extensive and intensive investment · Effective tax rates · Costs of public funds

JEL Classification D21 · F23 · H25 · L11 · L22

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1 Introduction

With increasing mobility of firms, international competitiveness has become a dominating concern in tax reform. Policy makers give priority to creating a favorable tax environment to attract internationally mobile firms. It is believed that a company's average tax rate is the decisive measure when a country wants to become more attractive as a location of foreign direct investment (FDI). A low *effective average tax rate* (EATR), compared to other countries, helps to keep mobile firms at home, and thus reduces outbound FDI. The EATR refers to discrete location choice or the extensive margin of capital formation. The *effective marginal tax rate* (EMTR), in contrast, refers to the intensive margin making existing firms grow larger. The EMTR is thus believed to be relevant for the growth of domestic businesses which refrain from FDI and, if at all, serve foreign markets via exports. The voluminous study of the European Commission (2001) on company taxation in Europe has provided detailed compilations of EMTRs and EATRs in an intra-European and world wide comparison.¹ The measurement of effective tax rates is summarized by Devereux and Griffith (2003) and Sorensen (2004).

Much of the international tax literature (see the reviews of Gordon and Hines 2002; Gresik 2001; Weichenrieder 1995, and Janeba 1997, or the papers by Haufler and Schjelderup 2000, and Davies 2004, to mention a few contributions) postulates that multinational investment flows occur until the marginal product of capital is equalized across countries. Taxes may drive a wedge between gross returns across countries and thereby lead to an inefficient international allocation of capital. However, it is not possible to rationalize the role of EATRs in a framework that allows only for marginal investments but excludes the discrete nature of FDI. The results in Hines (1996) point to the sensitivity of international investment with respect to average tax measures.

Devereux and Griffith (1998) systematically introduced the concept of the average effective tax rate to explain discrete investment choices including location decisions of multinationals (see Devereux et al. 2002, and Devereux 2007, for reviews). Their analysis is based on a theoretical framework which draws on the basic structure of Horstman and Markusen (1992) and emphasizes the role of the EATR for location choice and the EMTR for investment decisions or plant size conditional on location choice. Devereux and Griffith (2003) developed the methodology for measuring EATRs, thereby complementing the King–Fullerton formulas on EMTRs. They also showed that the EATR can be expressed as a weighted average of the statutory corporate tax rate and the associated EMTR. Subsequent empirical work is based on these concepts and shows the differential impact of corporate taxes on location and scale of multinational investment. Buettner and Ruf (2007) show how the corporate tax affects the scale of multinational investment via the EMTR measure while location is sensitive to the statutory tax rate which is a good proxy for the EATR (see

¹ Tax reform increasingly aims to create an internationally more competitive tax environment and tends to focus on EATRs. The German Council of Economic Advisors (GCEA 2006), for example, compiles and internationally compares EATRs to show how its proposal improves Germany's ranking. The role of EMTRs for investment of nationally operating firms are relatively neglected. The US has also become more concerned with the international impact of taxes, see the President's Advisory Panel on Federal Tax Reform (2006). For Canada, see the Technical Committee on Business Taxation (1997).

also Buettner and Wamser 2006, on the role of other taxes). Devereux and Lockwood (2006) analyzed how the investment decisions on location and scale (conditional on location) determine the aggregate capital stock of multinational firms. They emphasize that MNE capital stocks are much more sensitive to average tax rates rather than marginal ones.

The recent theoretical literature has studied models of FDI in imperfectly competitive markets to investigate the impact of taxes on discrete location choice (see Devereux and Hubbard 2003; Fuest 2005, or Bond 2000, for an early discussion). In emphasizing the role of taxes to influence international investment behavior of multinational firms, these papers tend to abstract from the impact of taxes on immobile, local firms which are restricted to the intensive margin of business investment. Razin and Sadka (2007a, 2007b) have developed a model of heterogeneous firms including location choice and intensive investment as well. They use the framework to guide empirical estimation and to simulate the consequences of tax competition and harmonization. They are not concerned to analytically demonstrate the separate role of extensive and intensive investment for national capital formation and the cost of public funds.

This paper draws on new trade theory which emphasizes firm heterogeneity and explains how firms choose between exports and FDI as alternative means to serve foreign markets (see Melitz 2003; Grossman et al. 2006; Helpman 2006; Helpman et al. 2004; Baldwin 2005, and Baldwin and Forslid 2004, among others). We thus obtain a general equilibrium model with an endogenous decomposition of a country's business sector into local and multinational firms. Local firms produce at home and export to foreign markets while multinational firms relocate production to foreign markets. The EMTR affects the scale (plant size) of both local and multinational investments. The EATR endogenously determines the composition of the business sector into local and multinational firms. A high EATR leads more firms to relocate export production to foreign markets which makes them truly multinational enterprises (MNEs). To analyze these issues, the paper formulates an intertemporal version of the "Melitz model" with capital while the standard model is static with labor being the only factor. Another novelty is the probabilistic formulation of the Melitz model which is much simpler and yet includes the same basic trade-offs. Heterogeneous success probabilities in foreign market entry replace the productivity differences in the Melitz model.² The symmetry of firms with respect to all other characteristics keeps the model very tractable. Given extra fixed costs of FDI, only firms with a high success probability of entering foreign markets will prefer FDI over exports. Firms with a low success probability will not be able to break even on FDI since FDI must also pay back the fixed cost of establishing foreign subsidiaries. The choice between FDI and exports reflects a proximity concentration trade-off: FDI saves transport costs but duplicates production and fixed costs.

²Bernard et al. (2006) emphasize that empirically more productive firms are "more likely" to start exporting. High productivity does not deterministically imply export status. Export status is only more frequent, or more likely, among these firms. This lends some realism to our probabilistic formulation. Grossman and Helpman (2004) also include success probabilities to clarify the role of managerial incentives, although again firm heterogeneity is in factor productivity.

Based on this general equilibrium model with outward FDI, the paper shows how the EMTR and EATR measures of the corporate tax play together to determine the *net* impact on aggregate national investment. Domestic capital formation results from the net impact on expansion investment of local production units (intensive margin) and FDI reflecting the relocation decisions of firms (extensive margin). The paper thus endogenously explains the impact of the corporate tax on the equilibrium number of MNEs in the economy. It also appropriately defines the extensive and intensive elasticities of national investment, reflecting the aggregate consequences of the scale and location decisions of individual firms. The paper then shows how the behavioral responses on these two margins determine the aggregate capital stock, aggregate tax revenues raised from different types of firms, and household sector welfare. In particular, the paper derives a welfare based measure of the cost of public funds of the corporate income tax and shows how it depends on the extensive and intensive elasticities and the two measures of effective tax rates. Section 2 sets up the basic framework. Section 3 states comparative static results and characterizes the costs of public funds. Section 4 concludes.

2 The model

The argument is based on a simple two period model of a small economy with monopolistic competition and variable outbound FDI.³ In the first period, a fixed labor endowment is employed to produce a traditional good (numeraire) which can be consumed or invested. The traditional sector employs a Ricardian technology with a unit labor coefficient and pays a wage rate of one. A fixed number of n industrial firms each invests capital (standard good) in period one to supply differentiated goods in period two. Each firm is endowed with a worldwide patent for a specific brand which is a close substitute for other varieties. The firm faces demand worldwide and produces under conditions of monopolistic competition. A key business choice is whether firms should serve the foreign market via exports from home subject to transport costs. Alternatively, they could save on transport costs by relocating production abroad and serving the market locally. However, establishing a foreign subsidiary company requires extra administrative and other fixed costs.

Decision making by firms follows a logical sequence. To begin with, firms inherit a product design from past innovation and a probability that the product will actually be valued by consumers. To keep things simple, we assume that a new product designed by domestic firms always appeals to consumers in the home market. Firms then invest in a production unit and finally supply the market. In contrast, the firm may or may not be able to penetrate the foreign market. The success probability of foreign market introduction varies among the fixed number of brands. Firms must first decide whether they serve foreign markets with exports or FDI. Second, after they spend the relevant fixed cost to prepare market entry, the success of market introduction becomes known. If entry fails, the fixed cost is wasted. Third, when the market is successfully developed, they choose capital investment (at home or abroad,

³For simplicity, we consider only outbound FDI by domestic firms and disregard inbound FDI.

depending on the export FDI choice) which fixes plant size and sales volume. Fourth, firms distribute profits and consumers allocate income to innovative and traditional goods. The presentation of the model follows the principle of backward induction and starts with consumer choice.

2.1 Demand

Domestic households are endowed with fixed labor L in the first period, earning a wage $w = 1$ per unit. Households spend labor income on consumption C_1 of the standard good (numeraire) and save the rest. In the second period, savings S yield total wealth RS including interest r where $R = 1 + r$. In addition, agents receive profits π^e from ownership of monopolistic firms and get lump-sum transfers z from the government. They spend C_2 on consumption of the traditional good and E on their purchases of n differentiated goods. Each brand is available at a producer price p_j and is consumed in quantity c_j . Spending is constrained by first and second period budgets

$$C_1 = L - S, \quad C_2 + E = RS + \pi^e + z, \quad E = \int_0^n (1 - v) p_j c_j dj = n(1 - v) p c. \quad (2.1)$$

The last equality reflects the symmetric nature of preferences and costs. We also include a demand subsidy for differentiated goods at rate v . The subsidy is merely a technical device that serves to eliminate the markup pricing distortion if needed (see, e.g., Keuschnigg 1998). Given producer prices p_j , the consumer price is reduced to $(1 - v)p_j$. Eliminating savings yields the intertemporal budget constraint. It will be convenient to express it in second period units, $RC_1 + C_2 + E = LR + \pi^e + z$.

Assuming linearly separable preferences, present and future consumption are perfect substitutes. The interest rate r must thus be equal to the subjective discount rate. Consumers do not care *when* to consume but care only about total consumption. Lifetime utility in second period units is $U = RC_1 + C_2 + \int_0^n u(c_j) dj$, or

$$U = LR + \pi^e + z + \int_0^n [u(c_j) - (1 - v)p_j c_j] dj. \quad (2.2)$$

The square bracket gives consumer surplus from consumption of innovative goods. Demand follows from utility maximization which results in $(1 - v)p_j = u'(c_j)$.⁴ Specializing to $u(c_j) = A^{1-\alpha} \cdot (c_j)^\alpha / \alpha$, $0 < \alpha < 1$, and denoting the price elasticity by $\varepsilon = 1/(1 - \alpha) > 1$, domestic demand for brand j is

$$c_j = A / ((1 - v)p_j)^\varepsilon, \quad c_j^f = A^f / (p_j^f)^\varepsilon. \quad (2.3)$$

Foreign demand is marked by an upper index f and stems from similar preferences. In the foreign economy, households consume traditional and innovative goods while producers are specialized in the *numeraire* good only. However, the foreign economy also hosts incoming FDI to manufacture differentiated goods locally. The Appendix establishes general equilibrium of the world economy.

⁴Following Krugman (1980), we have assumed additively separable preferences for differentiated goods. For this reason, the demand function does not include a price index.

2.2 Home market production

Firms always produce for the home market, but serve the foreign market only when market access is successful. To supply the home market, firm j invests k_j units of the standard good in the first period. Anticipating symmetry, we suppress the variety index j . Since capital does not depreciate, investment yields k units of the standard good in the second period. At the same time, capital is used to produce k units of a differentiated good. The monopolistic firm supplies the entire domestic market, $c = k$, and earns revenues pk .⁵ The government levies a corporate profit tax at rate t , but allows deduction of ek from the tax base. When $e = 1$, firms can fully deduct investment, making the corporate tax a cash-flow tax. If $e < 1$, the tax discriminates against investment. The discounted present value of the firm's production for the home market is $[(1 - t)pk + (1 - et)k]/R - (1 - et)k$. Measured in units of the second period, firm value is

$$\pi = (1 - t)pk - (1 - et)rk. \quad (2.4)$$

In period two, tax revenue amounts to $\pi^T = t(pk + ek) - tekR = t(p - er)k$.

In solving for optimal investment, the firm takes account of its monopoly position $c = k$ in the market for her brand. Using (2.3), the revenue function is seen to be concave in capital,⁶ $p(k)k = k^\alpha \cdot A^{1-\alpha}/(1 - v)$. Alternatively, using $k = A/[(1 - v)p]^\varepsilon$, the firm's revenue from domestic sales amounts to

$$p \cdot k = A \cdot (1 - v)^{-\varepsilon} \cdot p^{1-\varepsilon}. \quad (2.5)$$

Slightly rewriting (2.4), the monopolistically competitive firm's investment follows from

$$\pi = \max_k (1 - t)(pk - uk), \quad u \equiv \frac{1 - et}{1 - t} \cdot r, \quad (2.6)$$

where u stands for the user cost of capital. Taking account of the fact that any increased output from additional investment reduces the producer price p , the optimality condition becomes $p - u + k \cdot dp/dk = 0$. Using the price elasticity given in (2.3) yields

$$\alpha \cdot p(k) = u, \quad k = A \cdot (\alpha / [(1 - v)u])^\varepsilon. \quad (2.7)$$

The firm invests until marginal revenue is equal to marginal cost. Consequently, the price of the variety is a fixed markup $1/\alpha$ over the user cost of capital. The demand curve determines the level of sales at this price which, in turn, yields output and capital invested. A closed form solution for profits is found when using $\alpha p = u$ to

⁵In the absence of taxes, the present value of a firm with investment k is $(pk + k)/R - k$ which amounts to $\pi = pk - rk$ if expressed in second period values. Mark-up pricing over marginal cost, $p > r$, yields strictly positive profits indicating an excess return on capital over its user cost r .

⁶For this reason, we can keep technology linear. A concave net output function $f(k)$ would only complicate the analysis without additional insights.

substitute out u in (2.6) which yields $\pi = (1 - t)(1 - \alpha)pk$. Replace pk by (2.5) and again use the markup $p = u/\alpha$ to arrive at

$$\pi = (1 - t)B/u^{\varepsilon-1}, \quad B \equiv (1 - \alpha)A\alpha^{\varepsilon-1}/(1 - \nu)^{\varepsilon}. \quad (2.8)$$

2.3 Foreign market entry

A domestic firm with a given product design can sell its brand worldwide. Suppose that the firm has decided to serve the foreign market with exports and that foreign market entry was successful. Exports involve real trade costs $\theta - 1$ of shipping goods across border. To cover transport cost, the foreign demand price must exceed the domestic producer price by a factor θ . For the same reason, an export firm must produce more than what arrives at foreign consumers, $k_X > c_X$. The difference is lost on transport. Given symmetry in export demand, we again suppress the variety index and write $c_X = c_j^f$ etc. Foreign demand prices and domestic producer prices for exports are thus related by

$$p_X = \theta p, \quad k_X = \theta c_X, \quad p_X \cdot c_X = p \cdot k_X, \quad \theta \geq 1. \quad (2.9)$$

When the monopolistic firm successfully picks up export business, it must invest an amount k_X of the standard good to build the export plant and thereby obtains a value π_X in addition to the value π of its plant that produces for the home market,

$$\pi_X = (1 - t)pk_X - (1 - et)rk_X = (1 - t)(p - u)k_X. \quad (2.10)$$

The exporting firm pays tax in the second period equal to $\pi_X^T = t(p - er)k_X$.

Since $p_X = \theta p$, export demand is $c_X = A^f/(\theta p)^{\varepsilon}$, giving revenues $pk_X = A^f/(\theta p)^{\varepsilon-1}$. By the same steps as before, exporters choose a markup over user cost of capital, $p = u/\alpha$. Profits from export business thus amount to $\pi_X = (1 - t)(1 - \alpha)pk_X$ or

$$\pi_X = (1 - t)B_X/u^{\varepsilon-1}, \quad B_X \equiv (1 - \alpha)A^f(\alpha/\theta)^{\varepsilon-1}. \quad (2.11)$$

Instead of exporting to the foreign market, the firm could have chosen FDI by establishing a foreign subsidiary. Since the corporate tax is a source tax, profits of the foreign subsidiary are subject to the foreign corporate tax which might result in double taxation of profits upon repatriation. The most commonly adopted rule in the taxation of MNEs is the exemption principle whereby profits of foreign subsidiaries are exempt from corporate tax in the parent country. Since the analysis in this paper keeps foreign taxes constant and is exclusively concerned with the intensive and extensive investment response to the domestic corporate tax, it is useful to entirely suppress foreign taxes. With a zero foreign tax rate and exemption at home, the user cost of capital invested abroad is equal to the foreign interest rate, $u^f = r$, which is, by assumption, equal to domestic interest.⁷

⁷If the home country applies the deduction or credit method in taxing foreign source profits, some double taxation might result. In such cases, the domestic tax rate also determines the cost of foreign invested capital and thereby changes, to some extent, the tax impact on the exports FDI choice.

Having opted for FDI to serve the foreign market, the firm saves on transport costs. Compared to an export firm, it can charge a lower price p_I to foreign customers which boosts sales. The value of the foreign subsidiary to the domestic parent company is

$$\pi_I = (p_I - r)k_I. \quad (2.12)$$

The export versus FDI decision explained below will be well behaved only if $\pi_I > \pi_X$. Local production abroad saves transport cost which allows a lower demand price, and thus boosts sales and profits, making FDI relatively more profitable compared to exporting.⁸

2.4 Exports versus FDI

The key element of the model refers to the choice of domestic firms to serve foreign markets via two rivaling modes: exports or FDI.⁹ The decision defines the extensive margin of investment by relocating production and investing abroad if exporting becomes less attractive than foreign subsidiary production. The simplest approach is to assume that foreign market entry is risky and firms succeed only with probability q . All firms attempt foreign market entry, but some will not be successful so that there is a margin of purely local firms that earn π only. If market entry fails, the fixed cost spent on preparing market access is lost. Total profit of successful firms from global sales amount to $\pi + \pi_X$ for exporters and $\pi + \pi_I$ for a multinational company with foreign subsidiaries. Ex ante, when foreign market entry is still uncertain, the expected value of global sales is

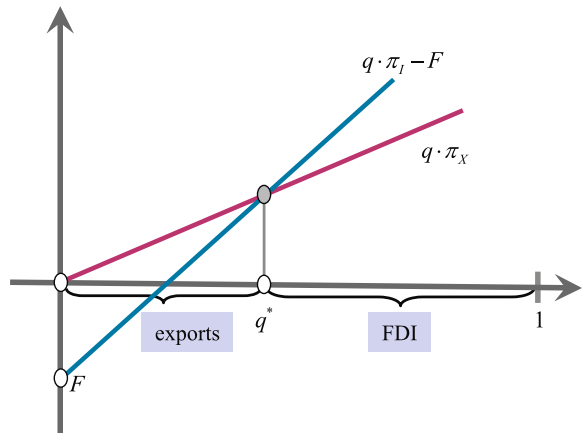
$$\bar{\pi}_X = \pi + q \cdot \pi_X, \quad \bar{\pi}_I = \pi + q \cdot \pi_I. \quad (2.13)$$

Preparing foreign market entry requires some fixed costs such as building a distribution network, fulfilling foreign regulations etc. They are normalized to zero for exports, $f_X = 0$, making exports the default mode.¹⁰ Opting for FDI by establishing a foreign subsidiary is more expensive. Suppose there are *differential* fixed costs f_I relating to FDI. Ex ante, before the success of market entry is known, the expected present value of a foreign subsidiary, net of these fixed costs, would be $q \cdot \pi_I / R - f_I$. In terms of second period values, it amounts to $q \cdot \pi_I - F$ where $F \equiv Rf_I$.

⁸By similar steps as before, foreign subsidiaries set a markup of producer price over foreign user cost as in (2.7), $\alpha p_I = r$. The profit thus is $\pi_I = (1 - \alpha)p_I k_I = (1 - \alpha)A^f (\alpha/r)^{\varepsilon-1}$. Comparing closed form profits, the inequality is equivalent to $1/r^{\varepsilon-1} > (1-t)/(\theta u)^{\varepsilon-1}$. It is satisfied in the absence of tax where $u = r$. If real trade costs are positive, $\theta > 1$, the condition reduces to $1 > 1/\theta^{\varepsilon-1}$ and is necessarily fulfilled since $\varepsilon > 1$ as well. If taxes are not too large, the inequality also holds with positive taxes.

⁹To endogenize this margin, we choose a much simplified “Melitz model” of monopolistic competition (see Melitz 2003). Instead of considering firm heterogeneity in labor productivity, giving rise to a distribution of unit costs, prices, demand, and firm size, we assume identical productivity across firms and keep the production and demand side symmetric. The only heterogeneity is the risk of foreign market entry. Our assumptions much increase analytical tractability which has plagued the applications of the Melitz model. One disadvantage is that we cannot capture how trade and fiscal policy change aggregate productivity by affecting firm composition. However, this aspect is not the focus of the paper.

¹⁰If f_X were positive, some firms would not attempt foreign market entry at all and choose to stay local from the beginning.

Fig. 1 Exports versus FDI

As a result of past innovation, new product designs are endowed with variable probabilities q . The extra fixed cost F necessary for FDI is lost without any gain if market entry fails. FDI is thus worthwhile only for products with a sufficiently high probability of foreign market access. The critical, indifferent firm is defined by

$$q^* \cdot (\pi_I - \pi_X) = F, \quad F \equiv f_I R. \quad (2.14)$$

Figure 1 illustrates the choice between exports and FDI. Since exports involve transport costs, variable profits are larger when producing locally, $\pi_I > \pi_X$. FDI, however, creates higher fixed costs. If a firm will be successful in introducing her brand in the foreign market with a low probability q only, the differential profit $\pi_I - \pi_X$ from FDI will materialize only rarely while the fixed cost of establishing the subsidiary is necessary in any case. Choosing FDI instead of exports is thus not profitable for firms which stand a low chance of successful foreign market access.

An innovation results in a new specialized brand with uncertain market prospects. Some brands are more appealing to consumers than others. We assume that each brand is drawn from a pool of possible innovations where the success probability q is represented with density $g(q)$, yielding a cumulative distribution $G(q) = \int_0^q g(q') dq'$. Given (a fixed number of) n independent innovations, the mass of firms with success probability q is $g(q)n$. According to Fig. 1 and (2.14), all firms with success probabilities smaller than the critical one, $q < q^*$, choose exports, the rest opts for FDI. In the aggregate, of all n domestic firms, a share s_F invests the necessary fixed cost F and attempts FDI. The remaining share $1 - s_F$ opts for the export strategy.

Since foreign market entry is risky and fails with probability q , the fraction of *successful* market entrants is much smaller, i.e., $s_I < s_F$, $s_X < 1 - s_F$ and thereby $s_I + s_X < 1$. The remaining part $1 - s_I - s_X$ is not successful in penetrating foreign markets, stays national and serves only the local market. Therefore, the range of goods available abroad is smaller than the menu of varieties offered at home:

$$s_X = \int_0^{q^*} q dG(q), \quad s_I = \int_{q^*}^1 q dG(q), \quad s_F = \int_{q^*}^1 dG(q). \quad (2.15)$$

Each firm earns strictly positive rents in the second period. Domestic households collect profits with a total value of π^e . From now on, we normalize the mass of firms to unity, $n = 1$, so that s_X denotes the mass as well as the share of exporters:

$$\pi^e = \pi + s_X \cdot \pi_X + V_I, \quad V_I = \int_{q^*}^1 (q \cdot \pi_I - F) dG(q) = s_I \cdot \pi_I - s_F \cdot F. \quad (2.16)$$

The aggregate value of repatriated profits from foreign subsidiaries, net of fixed costs spent abroad, is V_I . Repatriated profits are part of the economy's net foreign factor income.

2.5 General equilibrium

The government is assumed to refund tax revenue in the second period net of the demand subsidy as lump-sum transfers to households. Since corporate tax revenue stems only from firms producing at home, the public sector budget is

$$z = t \cdot (p - er)K - vpc, \quad K \equiv k + s_X k_X. \quad (2.17)$$

The aggregate domestic capital stock reflects investments in all plants that serve the domestic market and those that produce for exports. Outbound FDI of domestic MNEs equal to $s_I k_I$ adds to the foreign country's capital stock. Intensive investment relates to the size of plants located at home, k and k_X . Extensive investment reflects relocation of production to the foreign country as a result of the export FDI choice illustrated in Fig. 1, and is felt in a smaller or larger number s_X of export plants located at home rather than abroad. The Appendix in Keuschnigg (2006) derives the aggregate savings investment identity and the world output market equilibrium.

3 Impact and cost of corporate taxation

The purpose of the paper is twofold. We first show how the measures of effective marginal and average tax rates, EMTRs, and EATRs, interact to determine the net impact on national investment. We will find an important interaction. The EMTR not only affects intensive but also extensive investment by its impact on plant size. Next, the paper shows how the excess burden of the corporate tax is measured, using the effective tax rates and appropriately defined behavioral elasticities.

3.1 Effective average and marginal tax rates

The EMTR measures the tax burden on marginal investment. The tax drives a wedge between the pretax return or cost of capital u , equal to marginal revenue αp , and the after tax return r . In pushing up the pretax return, it makes the last units of investment unprofitable and impairs business growth. Using (2.6), the EMTR, denoted by t_m , is

$$t_m \equiv \frac{u - r}{u} = \frac{(1 - e)t}{1 - et}, \quad 1 - t_m = \frac{1 - t}{1 - et}. \quad (3.1)$$

The EMTR relates gross and net returns by $r = (1 - t_m)u$ and summarizes all relevant parameters of the tax code in a single measure of the distortion on the intensive margin. It is well known that immediate expensing ($e = 1$) transforms the corporate tax into a cash-flow tax, and consequently results in a zero EMTR. When there is no expensing at all, $e = 0$, the EMTR coincides with the statutory tax rate, $t_m = t$.

The EATR measures total taxes paid as a share of gross income. In an intertemporal model, the relevant concept is the ratio of the present value of tax liability over the gross, social present value of the firm. Using (2.4), the relevant values in second period units are $\pi^* \equiv \pi + \pi^T = (p - r)k$ and $\pi^T = t(p - er)k$. The EATR is thus defined as

$$t_a \equiv \frac{\pi^T}{\pi^*} = \frac{p - er}{p - r} \cdot t, \quad 1 - t_a = \frac{\pi}{\pi^*} = (1 - t) \frac{p - u}{p - r}. \quad (3.2)$$

With π^* being the gross value of the firm, net profits and tax payments are $\pi = (1 - t_a)\pi^*$ and $\pi^T = t_a\pi^*$ where $\pi^* = \pi + \pi^T$.

To derive comparative static effects of tax reform, we compute changes of variables relative to their values in the initial equilibrium. The hat notation indicates relative changes such as $\hat{u} \equiv du/u$. The exceptions are changes in tax rates which are expressed relative to net of tax prices, e.g., $\hat{t}_m \equiv dt_m/(1 - t_m)$. Since $(1 - t_m)u = r$ and the markup is constant, user cost, and producer price change in proportion to the EMTR,

$$\hat{p} = \hat{u} = \hat{t}_m. \quad (3.3)$$

How are the effective rates changed by an increase in the statutory rate? The EATR is an endogenous tax measure that must be determined jointly with the impact of taxes on equilibrium. Its relative change is found by log-linearizing the equation for $1 - t_a$ in (3.2), yielding $-\hat{t}_a = -\hat{t} + \frac{dp - du}{p - u} - \frac{dp}{p - r}$. Appropriately expanding and noting (3.3) gives

$$\hat{t}_a = \hat{t} + \frac{r}{p - r} \cdot \hat{t}_m, \quad \hat{t}_m = \frac{1 - e}{1 - et} \cdot \hat{t}. \quad (3.4)$$

A first insight is that the statutory rate changes the EATR, as defined in (3.2), both directly as well as indirectly via its impact on the EMTR which pushes up the user cost and, via markup pricing, the variety prices. Quite intuitively, a cash-flow tax with immediate expensing is neutral on the intensive margin. In this case, the EATR is identical to the statutory rate, $\hat{t}_m = 0$ and $\hat{t}_a = \hat{t}$.

3.2 Investment and profits

The EMTR pushes up the user cost of capital and leads firms to charge higher prices. To sustain higher prices, the monopolist must cut back sales and invests less. By the demand curve in (2.3),

$$\hat{k} = -\varepsilon \cdot \hat{p} = -\varepsilon \cdot \hat{t}_m. \quad (3.5)$$

The firm's net of tax profit depends both on the average and marginal tax rates. To see this, note that gross profit is $\pi^* = (p - r)k$, leaving a net of tax profit $\pi =$

$(1 - t_a)\pi^*$. Gross profit in log-linearized form is $\hat{\pi}^* = \frac{p}{p-r} \cdot \hat{p} + \hat{k}$. Substitute the preceding results,

$$\hat{\pi} = \hat{\pi}^* - \hat{t}_a = -\left(\varepsilon - \frac{p}{p-r}\right) \cdot \hat{t}_m - \hat{t}_a = -\frac{p-er}{p-u} \cdot \hat{t}, \quad \hat{\pi}_X = \hat{\pi}. \quad (3.6)$$

To obtain the third equality, use $\varepsilon = 1/(1 - \alpha)$ and eliminate α by the condition (2.7) to get $\varepsilon = p/(p - u)$. Insert this and \hat{t}_a from (3.4) into the round bracket which yields $\hat{\pi} = -\frac{u}{p-u} \hat{t}_m - \hat{t}$. Substitute now for \hat{t}_m and use u from (2.6) to obtain, after some rearrangements, the result. The third equality states the net effect which is induced by the statutory rate. It is also directly obtained by applying the envelope theorem to (2.4), $d\pi/dt = -(p - er)k$, and dividing this by $\pi = (1 - t)(p - u)k$. A cash-flow tax implies $e = 1$ and $u = r$, yielding $t_m = 0$ and $t_a = t$. It is not distorting intensive investment. An increase in the statutory rate would thus leave gross profit unaffected, $\hat{\pi}^* = 0$, and reduce net of tax profit by $\hat{\pi} = -\hat{t}_a = -\hat{t}$.

Other things being constant, an increase in the statutory tax rate reduces exporting profits in exactly the same way. Although the level of demand is different, the relative change in net profits is the same because the demand elasticity is identical in home and foreign markets. Assuming that the home country applies the exemption method to avoid double taxation, profits of foreign subsidiaries net of foreign corporate tax are exempted at home. Hence, profits π_I from FDI are unaffected by domestic taxation, see (2.12). Investment of foreign subsidiaries depends only on foreign user cost that is possibly inflated by foreign taxes, but does not change with home taxes.

The FDI export trade-off is illustrated in Fig. 1 and formally resolved by fixing the cut-off value q^* in (2.14). Log-differentiating yields $\hat{q}^* = \hat{\pi}_X \cdot \pi_X / (\pi_I - \pi_X)$ since profits π_I of foreign subsidiaries are exogenous from the home economy's perspective. Inserting the change in export profits from above yields

$$\hat{q}^* = \frac{\pi_X}{\pi_I - \pi_X} \cdot \hat{\pi}_X, \quad \hat{\pi}_X = -\frac{p-er}{p-u} \cdot \hat{t}. \quad (3.7)$$

Domestic corporate taxation raises outbound FDI for two reasons. First, it raises the EATR and thereby reduces the net of tax profit from exporting, making it more attractive to serve foreign markets via FDI. Second, it also raises the EMTR, thereby impairing investment and company growth and reducing profits from domestic export production. The net effect is given in (3.6) and makes exports less profitable relative to the FDI alternative. In reducing the cut-off value that identifies the critical firm, the tax shrinks the number of domestically producing exporters. As more firms decide to serve foreign demand locally by relocating production abroad, the decomposition of firms into exporters and multinationals changes in favor of MNEs. Applying the Leibnitz rule of differentiating integrals to (2.15) yields $ds_X/dq^* = q^*g(q^*)$, and similarly for the other shares. Expressing in relative changes gives

$$\hat{s}_X = \mu_X \cdot \hat{q}^*, \quad \hat{s}_I = -\mu_I \cdot \hat{q}^*, \quad \hat{s}_F = -\mu_F \cdot \hat{q}^*, \quad (3.8)$$

where the coefficients $\mu_X \equiv (q^*)^2 g(q^*)/s_X$, $\mu_I \equiv (q^*)^2 g(q^*)/s_I$ and $\mu_F \equiv q^* g(q^*)/s_F$ are defined as positive values.

Aggregate national investment reflects intensive (via k and k_X) and extensive investment (via s_X). Noting $\hat{k} = \hat{k}_X$, linearization of national investment in (2.17) yields

$$\hat{K} = \hat{k} + \frac{s_X k_X}{K} \cdot \hat{s}_X = \hat{k} + \eta \cdot \hat{\pi}_X, \quad \eta \equiv \frac{s_X k_X}{K} \frac{\mu_X \pi_X}{\pi_I - \pi_X}. \quad (3.9)$$

A higher corporate tax rate inflates the user cost of capital, suppresses business growth and distorts intensive investment. A higher tax rate also reduces profits from exporting relative to FDI and thereby distorts extensive investment. When exports become less profitable relative to FDI, more firms decide to relocate production and investment by establishing a subsidiary company close to foreign customers.

Profits of exporters and MNEs are different since only exporters are subject to transport costs and must therefore charge higher prices. Consequently, sales and profits are smaller. The corporate tax might thus affect aggregate profits π^e not only by diminishing the value of export profits but also by affecting firm composition. By (3.8), the effect of the cut-off probability on firm shares satisfies $ds_X = -ds_I = -q^* ds_F$. Hence, expected profits in (2.16) change by $\pi^e \hat{\pi}^e = \pi \hat{\pi} + s_X \pi_X \hat{\pi}_X + [q^* \cdot (\pi_I - \pi_X) - F] ds_F$. The last bracket is zero due to the endogenous export FDI choice. Substituting out the change in profits as in (3.6) yields

$$\pi^e \hat{\pi}^e = -(\pi + s_X \pi_X) \cdot \frac{p - er}{p - u} \cdot \hat{t}. \quad (3.10)$$

3.3 Cost of public funds

The deadweight loss of the corporate tax reflects the fact that the income equivalent welfare loss imposed on the private sector exceeds the extra tax revenue that is raised by government. To quantify the difference, it is convenient to define the tax base B and rewrite tax revenue, net of the demand subsidy, as

$$z = t \cdot B - v \cdot p \cdot c, \quad B \equiv (p - er)K. \quad (3.11)$$

Corporate tax revenue is $T = t \cdot B$ and changes by $dT = (1 - t)B[\hat{t} + \frac{t}{1-t}\hat{B}]$. The tax base responds to both firm size and location choice. If investment shrinks on the extensive margin, it leaves the margin $p - er$ constant but erodes the tax base by lowering investment K . Smaller firm size, however, not only reduces K , but also comes with a countervailing effect on the tax base since reduced output boosts prices, and thereby inflates the margin $p - er$. Making use of (3.5) and (3.9), the tax base adjusts by $\hat{B} = (1 - \frac{p}{p - er} \frac{1}{\varepsilon})\hat{k} + \eta \hat{\pi}_X$. By earlier definitions, tax liability and net profits of an export firm in terms of the average tax rate are $t(p - er)k_X = t_a \pi_X^*$ and $(1 - t)(p - u)k_X = \pi_X = (1 - t_a)\pi_X^*$. Dividing these relations implies $\frac{t}{1-t} \frac{p - er}{p - u} = \frac{t_a}{1 - t_a}$. Profits in (3.7) thus change by $\frac{t}{1-t} \hat{\pi}_X = -\frac{t_a}{1 - t_a} \hat{t}$. Substituting this together with $\hat{k} = -\varepsilon \hat{t}_m = -\varepsilon \frac{1 - e}{1 - et} \hat{t}$ yields, upon using (3.1),

$$\frac{t}{1 - t} \cdot \hat{B} = -\left[\frac{t_m}{1 - t_m} \mu \varepsilon + \frac{t_a}{1 - t_a} \eta \right] \cdot \hat{t}, \quad \mu \equiv \frac{1 - t_m}{1 - t} \left(1 - \frac{p}{p - er} \frac{1}{\varepsilon} \right) \geq 0. \quad (3.12)$$

The parameter μ controls the elasticity of the tax base with respect to intensive investment. With full expensing, $e = 1$, the user cost is equal to interest. Markup pricing yields $p/(p - r) = 1/(1 - \alpha) = \varepsilon$, giving $\mu = 0$. If there are no investment deductions, $e = 0$ and $t_m = t$, $\mu = \alpha$ so that tax base erosion due to reduced business growth is largest.

The change in corporate tax revenue noted after (3.11) thus becomes

$$dT = (1 - t)B \left[1 - \frac{t_m}{1 - t_m} \cdot \mu \varepsilon - \frac{t_a}{1 - t_a} \cdot \eta \right] \cdot \hat{t}. \quad (3.13)$$

The first term in the square bracket is simply the direct revenue effect from raising the tax rate. The second term relating to ε captures the distorting effect of the tax rate on intensive investment (or firm size) and on the producer price, which both affect the tax base. The third term relating to η shows how a high statutory tax rate erodes the tax base by reducing investment on the extensive margin, reflecting more outward FDI.

To characterize the deadweight loss, one starts by calculating the welfare change in (2.2), $dU = \pi^e \hat{\pi}^e + dz - (1 - v)c dp$. The last term reflects the loss of consumer surplus when the price marginally increases. To evaluate this formula, we first show how net profits and tax base B are related,

$$\pi + s_X \pi_X = (1 - t)(p - u)K = (1 - t)B \frac{p - u}{p - er}. \quad (3.14)$$

In consequence, the impact on total profits in (3.10) is $\pi^e \hat{\pi}^e = -(1 - t)B \cdot \hat{t}$. Further, (3.11) implies a change in transfers to households equal to $dz = dT - v \cdot d(pc)$. Substituting these results and using $c = k$, and $\hat{p} = -(1 - \alpha)\hat{k}$ from (2.4) together with $\hat{k} = -\varepsilon \hat{t}_m$, the welfare differential becomes

$$dU = -(1 - t)B \hat{t} + dT - (1 - v - \alpha) \cdot pk \cdot \varepsilon \hat{t}_m. \quad (3.15)$$

Substituting (3.13) and (3.4), the impact on welfare is

$$\frac{dU}{(1 - t)B} = - \left[\frac{t_m}{1 - t_m} \mu \varepsilon + \frac{t_a}{1 - t_a} \eta + \Omega \varepsilon \right] \hat{t}, \quad \Omega \equiv \frac{1 - v - \alpha}{(1 - t)B} \cdot \frac{(1 - e)pk}{1 - et}. \quad (3.16)$$

The last term Ω in the bracket reflects the effect of markup pricing on consumer surplus. In reducing intensive investment, the tax reduces sales and thereby leads to higher prices, which cuts into consumer surplus. This could be offset with an appropriate demand subsidy, which would ensure $(1 - v)p = u$ and thereby equate consumer price to marginal cost. Since markup pricing results in $\alpha p = u$, the required subsidy would be $1 - v = \alpha$. If the demand subsidy were optimally chosen in the initial equilibrium, the pricing distortion is eliminated ($\Omega = 0$). When the tax marginally increases the user cost and the producer price, the welfare impact of the price increase is zero to the first order. Of course, the welfare loss also disappears with $1 = e$ since in this case the tax does not distort intensive investment, leaving user cost and producer price unaffected. The first two terms in the square bracket relate to the twofold investment distortion. The distortion on the intensive margin depends on

the EMTR and the intensive investment elasticity ε . The distortion on the extensive margin depends on the EATR and the extensive elasticity η .

We can now measure the tax distortion in terms of the marginal deadweight loss per additional Euro of corporate tax revenue. Using (3.13) and (3.16),

$$\text{MDWL} \equiv \frac{-dU}{dT} = \frac{\frac{t_m}{1-t_m} \cdot \mu\varepsilon + \frac{t_a}{1-t_a} \cdot \eta + \Omega \cdot \varepsilon}{1 - \frac{t_m}{1-t_m} \cdot \mu\varepsilon - \frac{t_a}{1-t_a} \cdot \eta}. \quad (3.17)$$

The marginal cost of public funds is one plus the marginal deadweight loss,

$$\text{MCPF} = \frac{1 + \Omega \cdot \varepsilon}{1 - \frac{t_m}{1-t_m} \cdot \mu\varepsilon - \frac{t_a}{1-t_a} \cdot \eta}. \quad (3.18)$$

Except for the extra term Ω referring to the markup pricing distortion, this formula is entirely parallel to the analysis of intensive and extensive labor supply distortions. It compares, for example, with MCPF formula of Kleven and Kreiner (2006) if one reduces the household sector to only one income group. Their work is based on an earlier influential contribution by Saez (2002), see also Immervoll et al. (2007) and Dahlby (2008) for related work.

To evaluate the formula more fully, it is useful to discuss two special cases. Consider first the case where fixed costs of FDI are prohibitive which prevents any multinational investment at all. Therefore, the share of successful exporters s_X is fixed (and $s_I = s_F = 0$ in (2.14)) which eliminates the extensive margin of investment, $\eta = 0$. One is exclusively left with the standard distortion on the intensive margin where corporate taxation reduces the level of investment by domestic firms,

$$\text{MCPF} = \frac{1 + \Omega\varepsilon}{1 - \frac{t_m}{1-t_m} \cdot \mu\varepsilon}. \quad (3.19)$$

The cash-flow tax ($e = 1$) would be entirely neutral in this case, reducing t_m and Ω to zero. The tax is neutral not only with respect to intensive investment, but thereby also avoids the loss in consumer surplus from the pricing distortion.¹¹ The marginal cost of public funds would be one as with a lump-sum tax.

A second useful case to consider is an increase in the cash-flow tax with immediate expensing ($e = 1$). The EMTR is kept to zero since the tax entirely avoids the intensive distortion. The MCPF then reflects the distortion on the extensive margin only,

$$\text{MCPF} = \frac{1}{1 - \frac{t_a}{1-t_a} \cdot \eta}. \quad (3.20)$$

The cash-flow tax is thus not neutral in an economy with multinational investment. It raises revenue from the taxation of inframarginal profits which results in a substantial EATR and thereby distorts location choice. The magnitude of the distortion and the cost of public funds associated with the corporate tax depend on the EATR and the

¹¹The pricing distortion Ω could be eliminated in any case with a demand subsidy $v = 1 - \alpha$.

extensive elasticity η . This elasticity is defined in (3.9) and measures by how much aggregate investment K declines as more firms relocate investment and production from home to the foreign country in response to an increasing net of tax profit differential $\pi_I - \pi_X$ between export and FDI sales.

4 Conclusions

To the best of our knowledge, the public finance literature has not provided so far a consistent characterization of the intensive and extensive investment distortions associated with the corporate tax, or other taxes at the personal level which affect firm values and capital accumulation within firms. This gap is all the more serious since the policy oriented discussion has recently assigned a very prominent role to the importance of EATRs (see, for example, GCEA 2006, or European Commission 2001). The policy report by the GCEA does not even present any detailed calculations of the proposed reform on EMTRs, but emphasizes much the reduction of EATRs. A first insight from the theoretical analysis is that, strictly speaking, the EATR is not an independent but an endogenous tax measure that depends on the statutory tax rate as well as on the EMTR. The effective marginal rate affects firm growth and changes the firm's gross of tax value and the present value of tax payments. It thereby enters the EATR which is the ratio of these two values.

Traditional thinking is probably still much dominated by the excess burden associated with intensive investment. The surveys of the empirical literature by Devereux (2007) and De Mooij and Ederveen (2003) find that multinational investment responds sensitively to measures of statutory and average tax rates, and is more elastic than standard estimates of investment with respect to the user cost of capital suggest. The analyses of Buettner and Ruf (2007) and Buettner and Wamser (2006) show that corporate taxes affect both the scale and location of multinational investment. Given the elastic investment response on the extensive margin, the marginal cost of public funds due to the corporate tax must be revised up quite substantially since the tax shrinks aggregate investment on two margins: First, all domestically active firms invest less. Second, some firms no longer build new plants at home for export production but rather build them abroad to be closer to foreign customers. The welfare cost of the corporate tax is, therefore, importantly related to the size of the EATR and the extensive elasticity. This elasticity determines how many plants are built abroad rather than at home in response to a tax induced increase in differential net of tax profits. The analysis showed how the marginal cost of corporate taxation depends on the magnitude of effective average and marginal tax rates and appropriately defined behavioral elasticities of intensive and extensive investment response.

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